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Inventor:
  Address or whereabouts:
    C/O Ohtsuka Denki Co. 2-go 17-ban 6-chome Kami-odanaka Nakahara-ku Kawasaki-shi Kanagawa-ken
  Name: Kikuo Fujiwara

Inventor:
  Address or whereabouts:
    C/O Ohtsuka Denki Co. 2-go 17-ban 6-chome Kami-odanaka Nakahara-ku Kawasaki-shi Kanagawa-ken
  Name: Fumiyoshi Ohtsuka

Patent applicant:
  File number: 399081855
  Name or person or company:
    Ohtsuka Denki Co.

Attorney:
  File number: 100077849
  Attorney:
  Name: Saichi Suyama

Fee:
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Name of the file: Scope of the patent application

Application Item 1:

Conducting material with the following features: a heat conducting material consisting of a graphite molding body, and it has an endothermic part, a heat radiating part and a part that transfers heat from the endothermic part to the heat radiating part: also there is an insulating layer around this previously-mentioned heat conducting body and the previously-mentioned heat transfer route to cover at least part of the body.

Application Item 2:

Heat conducting material that consists of graphite molding body, and it has an endothermic part and a heat transfer route that disperses the heat generated from the previously mentioned endothermic part in both directions:

Heat conducting material has an insulating layer that covers at least partly around the previously mentioned heat transfer part of the previously mentioned heat conducting material.

Application Item 3:

In the heat conducting material of either Application Item No. 1 or 2, previously mentioned insulating layer is installed around previously mentioned heat transfer route in order to stop the dispersing of heat.

Application Item 4:

In the heat conducting material of either Application Item 1 or 3, the previously mentioned insulation layer is installed so that it covers the main circumference of the previously mentioned heat transfer route.

Application Item 5:

In the heat conducting material of either Application Item No. 1 or 4, the previously mentioned graphite molding body has over 100Wm·K heat conducting rate in the conducting direction of the previously mentioned heat transfer route.

Application 6:

In the heat conducting material of either No.1 or 5, the previously mentioned insulation layer is made of heat conducting material that has a heat conducting rate under 8W/m·K.

Application Item 7:

Radiation construction that is made to connect previously mentioned heating body to the radiator through the heat conducting medium, and the heat generated by the previously-mentioned heating body is dispersed by a radiator.

In the radiating construction, previously mentioned heat medium made by the previously mentioned heat conducting body in Application Item No.1.

Application Item 8:

Radiating construction that has a heating medium to transfer heat from the previously mentioned heating body, the previously mentioned heating medium is made of the heat conducting material mentioned in Application Item No. 2.

Name of the file: Details

Name of the invention: Heat conducting material and radiation system using a heat conducting material.

Technical field:

0001:

This invention concerns a heat conducting material that is used for various electronic parts such as semiconductor elements, and the radiation system construction.

Background field:

0002:

Electronic devices such as notebook personal computers, PDAs (Personal Digital Assistants) cell phones, or digital cameras have rapidly accelerating speed of function and processing capability. Consequently, the heat generated by the semiconductor elements and other electronic parts that are used for the CPU etc. is increasing. Also, devices that need lighting such as projectors require effective cooling systems.

0003:

In electronic devices that have high heat semiconductor elements, various types of cooling system (radiating system) are used: typical of those are, cooling by attaching a cooling fan to the high heating unit itself, cooling fin, Peltier element (cooling element), or exhausting heat inside the device by attaching an exhaust fan to the device itself. However, for portable electronic devices, as the size of devices becomes smaller, it is difficult to attach a cooling fan or fin to the device itself. On the other hand, , a semiconductor element cannot be cooled effectively by only exhausting the heat generated inside the electronic device.

0004:

Therefore, a heating unit such as a semiconductor element that is placed within the electronic device, and a radiating unit such as a radiating fan or fin placed outside the wall of the electronic device are connected by heat conducting material such as a heating pipe: this idea is in the process of actual use partially (for example, reference No. 1, 2) in order to save space for the heating system and at the same time to increase the cooling effectiveness of the semiconductor element. Not only that, use of graphite sheet (Patent reference 2, 3) is considered for the heat conducting material that connects the heating unit and the radiating unit.

0005:

The heat pipe as heat conducting material that connects the heating unit and the radiating unit, is good in effective heat conduction; however there is a limit to make it smaller—it is difficult to install inside a portable type electronic device. Also, it cannot effectively increase heat conduction in both directions on the surface, because in general a heat conducting body made of copper or aluminum has even heat conducting characteristics in all three dimensional directions. On the other hand, a graphite sheet has better heat conducting effect in both direction on a surface when it is compared with metal such as copper or aluminum; also it is light and flexible, so that it is considered to be a better heat conducting material for transferring heat from the heating unit to the radiating unit inside smaller portable type electronic devices.

0006:

However, when a graphite sheet is used merely for heat conducting material, heat around the graphite sheet will be dispersed while it is transferring the heat from the heating unit to the radiating unit; it also has the problem that it not only lowers the heat conduction rate, it can have

a bad affect on the conducting route and the surrounding parts. Especially, heat spots may occur on the opposite side of the heat conducting material made of graphite sheet, and it may have a bad affect on other parts eventually. The lowering of the heat conducting effect caused by a graphite sheet can lower cooling rate of the heating unit such as CPU. Also, many parts are placed within various portable type electronic devices that are sensitive to heat; therefore controlling the heat dispersion of the graphite sheet is very important.

Patent reference 1: Tokkai Hei8-204373, Open Journal

Patent reference 2: Tokkai2000-82888, Open Journal

Patent reference 3: Tokkai2-188323, Open Journal

Opening the of invention:

Problem that this invention is trying to solve:

0007:

As described above, a graphite sheet has high potential as a heat conducting material used for smaller size portable electronic devices because of high heat conducting characteristic in space direction and because of its lightness and flexibility; it also has the problems that heat dispersion around a graphite sheet while it is conducting heat from a heating unit to a radiation unit can have a bad affect on other parts or surrounding parts along the heat transfer route.

0008:

The purpose of this invention is to solve this problem: while we try to gain higher heat conducting effect, it is to offer a radiating unit which can be a smaller and more effective radiating system in various electronic devices, by using heat conducting material that has less bad affect on other parts.

The technology to solve the problems:

0009:

No. 1 of the heat conducting material of this invention has following characteristics: it is made of a graphite molding body, and it also has an endothermic part, a radiating part, and a heat conducting material with a heat transfer route from the endothermic part to the radiating part, and it has insulation which partially covers the heat transfer route. Also, the No. 2 heat conducting material is made of a graphite body, and it has heat conducting material with a heat transfer route so that it can disperse the heat made in the endothermic part (to mainly surface direction), and it has insulation around part of the heat transfer route of the heat conducting material.

0010:

The radiating construction of the No. 1 of this invention is made so that heat from the heating body will be transferred to the heating unit mentioned before through the heating medium, it also has a radiator which disperses heat from the heating unit mentioned before and the heating medium mentioned earlier is made of heat conducting material No. 1 of this invention, as described earlier. The No. 2 radiator construction is made so that heat will be relayed from the heating body and the heating body mentioned earlier through the heating medium, and the heating medium is made of the No. 2 heat conducting material of this invention as described earlier.

0011

The heat conducting material of this invention can control unnecessary heat dispersion from the heat transfer route, because insulation covers part of the heat transfer route of the heat

conducting body made of graphite mold. Therefore, the heat conducting effect of the heat conducting body made of graphite can be increased, at the same time it (the insulation cover) can decrease bad effects on other parts that are sensitive to heat, and parts located around the heat transfer route.

Effect of the Invention

0012:

By the heat conducting material of this invention, heat from the conducting body can be transferred effectively; at the same bad effects on other parts around heat transfer route or other parts, can be decreased. By using this kind of radiating unit made of heat conducting material, radiating effect (effective cooling rate) from the heating unit will be increased, and it is possible to construct a radiating system that is right for small and thin electronic devices.

0013:

I will explain the actual form of this invention showing drawings from now on.

0014:

Drawing 1 is a cross-section of the overall construction of heat conducting material according to the No. 1 actual form. The heat conducting material shown in the Drawing 1 has heat conducting body 2 made of graphite mold. At both ends of long direction of this heat conducting body 2 made of graphite mold, endothermic part 3 and heat radiator 4 are placed. That means, one end of the heat conducting material is an endothermic part (endothermic side end) 3, and the other end is the heat radiating part (heat radiating side end) 4.

0015:

In between endothermic part 3 and heat radiating part 4, is the heat transfer route 5 made of graphite mold. In other words, the heat conducting body 2 has a heat transfer route 5 made of graphite mold, and it transfers heat from the endothermic part 3 to the heat radiating part 4 in both directions. There is an insulation layer 6 around the heat transfer route 5 of this type of heat conducting body 2, thus the heat conducting material 1 consists of the heat conducting body 2 and insulation layer 6. The insulation layer 6 covers at least part of the heat transfer route 5 in order to control unnecessary heat dispersion around the heat transfer route.

0016:

In Drawing 1, we explain an example in which the endothermic part 3 and the heat radiator 4 are placed at both ends of the heat conducting body 2, but it is possible to place endothermic 3 and heat radiator 4 in a vicinity of the ends of the heat conducting body 2 as is shown in Drawing 2. Also, the heat conducting body shown in the Drawing 1 or 2 transfers heat to only one direction, but as in the example shown in Drawing 3, heat can be transferred from endothermic 3 in multiple directions of the heat radiators 4. The heat conducting body 2 in Drawing 3 has an endothermic part 3 which is placed at the center of the long direction of the heat transfer route 5, and it is constructed so that the heat from this endothermic part 3 can be transferred to heat radiator 4, 4 at the both end of the heat transfer route. It is possible to construct it in such a way that several endothermic parts 3 and the heat radiators 4 are placed.

0017:

The graphite molding body makes up the heat conducting body 2 is made of same surface direction layers of black lead crystal (graphite crystal). This type of graphite molding body is

strongly bonded toward the in-plane direction (c-plane direction of the hexagonal crystal system) of black lead crystal layer, but the bonding of in-layer direction of black lead crystal layer is weak. Therefore, heat conducting characteristic of graphite molding is aeolotropic, and it has good heat conducting only toward the in-plane direction (layer direction) of the black lead crystal layers. The graphite molding body has high heat conducting characteristic, for instance in-plane heat conducting rate is over 100W/m·K, or even 200W/m·K high heat conducting characteristic.

0018:

The heat transfer route 5 of the above-mentioned heat conducting body 2 is constructed so that the aeolotropic high heat conducting direction (direction with high heat conducting characteristic) and the heat conducting direction of the graphite molding body are the same. This type of heat conducting body 2 that has heat transfer route 5 can be obtained, for instance with press mold graphite flakes by molding such as rolling roll or press molding machine. The direction of layers of graphite flakes can be lined up easily perpendicular to the direction of the pressurizing roll based on its aeolotropic shape: for instance, by pressurizing sheet or thick board made of molded graphite body, graphite molding body that its plane direction is high conducting direction, can be made.

0019:

Procedure to make a graphite molding body is not limited to the above-mentioned pressurizing mold alone. The graphite molding body which has high heat conducting characteristic in the heat transfer direction can be made by extrusion mold of graphite flakes or graphite powder into a certain shape, or extrusion mold or pressurizing mold as heated amorphous carbon is added (to graphite flakes or powder). Moreover, for instance it can be made by heating with several 1000°C giant molecules, such as aromatic polyimide film, in an inactive gas atmosphere, to make a sheet of graphite molding body that has a high heat conduction characteristic in surface direction.

0020:

The shape of the graphite molding body that is made into a heat conducting body 2 (heat transfer route 5) is not limited to a particular shape; it can be freely set according to usage, place, and in relation to the heat transfer route, of the heat conducting material 1. But the thickness of (the graphite) when the heat transfer route 5 is perpendicular to heat conduction direction [?], in other words the thickness needed to transfer heat in the surface direction of the graphite molding body made in a sheet or thick board is preferably within 0.03-20mm. When the thickness of a sheet or thick board made by graphite molding body is under 0.03mm, effective heat conducting rate may be lowered by heat transfer route 5. On the other hand, if the graphite molding body is too thick, heat conduction rate will be lowered by heat resistance in the surface direction of the sheet or thick board; therefore the thickness of the graphite molding body is preferably under 20mm.

0021:

In the heat conducting body 2 made of the above-mentioned graphite molding body, insulation 6 is placed so that it covers at least part of the surface around the heat transfer route 5. The insulation 6 is to control unnecessary heat dispersion from the heat transfer route 5: in order to get this kind of characteristic, the heat conduction rate is preferably under 8W/m·K which is a low heat conduction rate. When the material of insulation 6 has a heat conduction rate higher than 8W/m·K, unnecessary heat dispersing from the heat transfer route 5 cannot be controlled

effectively. In other words, when the insulation layer 6 is made of insulation material with under 8W/m·K heat conducting rate, the heat conducting material 1 does not have to be too thick, therefore unnecessary heat dispersing from the heat transfer rout 5 can be controlled effectively. A heat conduction rate under 1W/m·K of the insulation layer 6 is even better.

0022:

As for material of the insulation layer 6, various materials can be used as long as they have a low heat conduction rate as described above. For instance, sheet type or film type giant molecular material may be used. Giant molecules used for the insulation 6, for instance resin material such as urethane resin, fluoro resin, silicone resin, or rubber material such as neoprene rubber or natural rubber can be used. Foaming resin such as polyurethane foam or polyethylene foam is especially good because of insulating characteristic. Also it is possible to construct the heat insulation 6 with inorganic material, such as glass, glass fiber, or low heat conducting zirconia or ceramics.

0023:

When giant molecule material in sheet or film forms is used for the insulation layer 6, it can be pasted onto the heat conducting body 2 with glue, thus the insulation layer 6 can be formed outside around the heat transfer route 5. Also, the insulation layer 6 can be formed when hard liquid resin compound or liquid rubber compound is pasted outside of the heat transfer route 5, and this pasted layer can be hardened by heating to form the insulation layer 6. When inorganic material such as glass or ceramics is used, the insulation layer 6 outside of the heat transfer route 5 can be formed by pasting or burning of liquid compound such as alkoxide solution, or glueing (two) sheets together.

0024:

The insulation layer 6 made of giant molecule materials (resin or rubber) or inorganic material (glass or ceramics) mentioned above, can function as an insulation layer or a supporting layer of mechanical strength of the heat conducting body 2 made of graphite molding body. Not only that, the thickness of the insulation layer 6 can be set freely according to heat insulation degree of the construction material: in reality, within the scope of 0.5-4mm is preferable. When the thickness of the heat insulation layer 6 is under 0.5mm, it is possible that unnecessary heat dispersion from the heat transfer 5 cannot be controlled effectively. On the other hand, if the thickness of the heat insulation layer 6 was over 4mm, not only heat dispersion controlling effect could not be obtained, but it might use too much space because the volume of the heat conducting material 1 might be.

0025:

The heat insulation layer 6 described above preferably covers the entire circumference of the heat transfer route 5, as shown in Drawing 4, in order to control unnecessary heat dispersion. But, for instance, as shown in Drawing 5, when heat conduction (cross section perpendicular to the heat conducting direction of the heat transfer route 5) by heat transfer route 5 is considered, when the ratio of the width of the conducting area W to the thickness t (t/W) is small enough, compared to the heating value from the circumference (upper side and lower side) along the width W, 5a, the heating value from circumference (both sides) along thickness t, 5b can be ignored. In this instance, the insulation layer 6 can be made to cover only the upper and lower parts of the main circumference of the heat transfer route, 5a, in order to control unnecessary heat dispersion from the heat transfer route 5.

0026:
Or, as shown in Drawing 6, the insulation layer 6 can be placed to cover only part of the circumference of the heat transfer route 5. While Drawings 4 & 5 show the construction to control heat dispersal over the entire circumference of the heat transfer route 5, Drawing 6 shows a construction to control heat dispersal only over a certain part of the heat transfer route 5. For instance, when parts that are sensitive to heat are located at certain sections of the circumference of the heat transfer route, the insulation layer 6 can be formed at those certain sections of the circumference of the heat transfer route in order to protect the parts from heat dispersion from the heat transfer route 5.

0027:
The above-mentioned heat conducting material 1 in actual form, because it uses the heat conducting body 2 made of simple construction graphite mold which has high heat conducting characteristic and light, can be used effectively as a heat conducting medium to disperse the heat generated from the heating body to the radiation body inside small electronic devices which have limited space. Not only that, since the insulation layer 6 is placed so as to cover the circumference of the heat transfer route 5 in order to control unnecessary heat dispersion from the heat transfer route 5, the heat conduction rate from the endothermic 3 to the heat radiator 4 through the heat transfer route 5 can be increased more.

0028:
Moreover when the insulation layer 6 is placed around the heat transfer route 5 made of graphite molding body, because it controls the unnecessary heat dispersion around the heat transfer route 5, for instance when parts of the device which are sensitive to heat have to be placed around the heat transfer route 5, the bad affect on those parts can be decreased greatly. Therefore, high density, small & thin electronic devices can be made.

0029:
Next, I will explain about actual form of the No. 2 heat conducting material in this invention, as it is referred to in Drawings 7 through 9. Drawings 7 through 9 are drawings of the overall construction of this heat conducting material in actual form: Drawing 7 is the cross section, Drawing 8 is the upper side, and Drawing 9 is the lower side. The heat conducting material 11 shown in these drawings has heat conducting body 12 made of a graphite molding body just like the No.1 actual form described above. The heat conducting body 12 made of graphite mold has an endothermic part 13 which has a heating unit at its center position: also it has a heat transfer route which disperses the heat from the endothermic part 13 in the surface direction. In other words, the heat generated from the endothermic part 13, is dispersed from the heat conduction body 12 made of graphite mold toward the surface direction, and the heat will finally be dispersed into the surroundings.

0030:
This heat conducting material 11 in this actual form uses a heat transfer route made of heat conduction body 12 as a heat radiating surface. In the usage of this type of the heat conducting body 12 made of graphite mold, because the opposite side of the endothermic part 13 of the heat conducting body 12 can be heated up easily, the insulation layer 14 is placed there. In other words, the insulation layer 14 is placed to cover part of the opposite side of the endothermic part

13 of the heat conducting body 12 in the heat transfer route. Such an insulation layer 6 prevents a spot at the backside of the endothermic part 13.

0031:

The heat conducting body 12 made of graphite mold or insulation layer 14 should preferably be similar in construction material and shape to the No.1 (conducting body) in actual form. And when parts which are sensitive to heat are placed around the heat conducting body 12, the insulation layer 14 can be applied there. Because the heat generated at the endothermic part 13 can be dispersed easily around the heat conducting body 12 made of graphite mold, for instance copper or aluminum that has isotropic heat conducting characteristic can be used as the endothermic body.

0032:

The actual form of the heat conducting material 11 described above has excellent heat conducting characteristics in the plane direction, and because it uses the heat conducting body 12 which is made of a light and simple construction graphite mold, the heat generated at the heating body can be dispersed effectively to the surroundings. In this instance, the temperature on the opposite side of the heat conducting body 12 and the endothermic part 13 easily goes up, and consequently hot spots may occur; but in the case of the actual form mentioned above, because the insulation layer 14 partially covers the opposite side of the heat conducting body 12 and the endothermic part 13, formation of hot spots can be prevented. Thus with this arrangement, the bad affect of the heat to the parts sensitive to heat around the heat conducting body 12 is diminished; therefore the electronic device can be made of high density or smaller and thinner.

0033:

Next, No. 1 actual form of the endothermic construction of this invention is explained referring to Drawing 10. Drawing 10 is an over-all drawing of the heat radiating construction according to the No. 1 actual form of this invention. The heat radiating construction body combines semi conducting element 21 as the heating body and heat radiating fin 22 as the heat radiating body, with the heat conducting material 1 which functions as the heating medium. The actual construction of the heating material 1 which functions as heating medium was described earlier in the No.1 actual form.

0034:

In the Drawing 10, heat radiating body is shown in a construction where a heat radiating fin 22 is used; but for the heat radiating body, well known radiation system or material such as a radiating fan or a radiating plate, etc. can be used. Also, the heating body is not limited to semi conducting element 21, but various electronic parts which require cooling can be considered. When a Peltier element is used, the form can be applied so that the heat generated on the side of the Peltier element can be transferred to a radiation body such as radiating fan, radiating fin, or radiating plate through heat conducting material 1.

0035:

One end of the heat conducting material 1 described above has the endothermic part 3 connected thermally to the semi conductor element 21, at the same time the heat radiating part 4 is connected thermally to the radiator fin 22 at the other end. Consequently, the heat generated from semiconductor element 21 is transferred to the heat radiator fin 22 through heat conducting

material 1 and dispersed into air from heat radiator fin 22. At the points where the endothermic part 3 meets the semiconductor element 21 and where the heat radiator 4 meets the heat radiating fin 22, heat conducting grease 23 such as heat conducting silicone grease with heat conducting particles can be placed to increase the heat conducting characteristic.

0036:

Because this type of heat radiating construction can transfer the heat generated from the semiconductor element 21 to the radiator fin 22 effectively, based on the high heat conducting characteristic of the heat conducting material 1 described above, the cooling of semiconductor element 21 is increased. Moreover, even if other parts are placed around the heat transfer route, there is no bad affect from the heat, consequently the design of the electronic device using the heat radiating construction is easier. That means that the production of high density, smaller, and thinner electronic devices using this heat radiating construction is possible.

0037:

As it has been described, with the actual form of the endothermic construction, it is possible to construct a small, space-saving and highly effective heat radiating system (cooling system) for the semiconductor element 21 etc. This type of heat radiating system (cooling system) is especially effective in portable electronic devices which are small and thin, so that space saving is essential. The example in which heat conducting material 1 and another body, heat radiator (fin) 22 are used, is shown in Drawing 10: but as shown in the Drawing 11, the fin construction can be formed directly on the heat radiator part 4 of graphite forming body; thus the heat conducting material 1 and the heat radiating body can be made as one body. This kind of construction saves even more space.

0038:

Next, I will explain the No. 2 actual form of the heat radiating construction of this invention referring to Drawing 12. Drawing 12 is a drawing to show the simple construction of the heat radiating construction according to No. 2 actual form of this invention. The heat radiating construction on that drawing is made in such a way that the heat generating body, the semiconductor element 21 is placed at the endothermic part 13 of the heat conducting material 11. The actual construction of the heat conducting material 11 which functions as the heat medium, is the same as before, as described in the No. 2 actual form. The heat conducting material 11 is bonded thermally with the endothermic part 13 to the semi conductor element 21, and the heat generated at the semi conductor element 21 is dispersed through heat conducting body 12.

This kind of construction of a heat conductor can increase the cooling effect of the semiconductor element 21, because, based on the high conductivity of the heat conducting material 11, the heat generated from the semi conducting element 21 can radiate effectively from the heat conducting body 12. Based on that, even when other parts are placed around the heat conducting material 11 or at wrong side of the semi conductor element 21, the bad heating affect can be diminished. Therefore, higher density design, with more compact and thinner shape of electronic devices that has radiating construction body, can be made. In other words, according to this actual form of radiating construction, the radiating system (cooling system) such as semiconductor element 21 etc., can be made in compact, saving space yet highly effective way.

Actual Samples

0040:

Actual Sample 1, Comparison Sample 1-3

First, a graphite sheet, with heat conducting rate 230W/m·K in the plane (side) direction, and heat conducting rate 10W/m·K in the plane thickness (vertical) direction, was prepared as the heat conducting material and the radiating construction shown on the Drawings 13 and 14. The main surface of the graphite sheet 31 was covered by a 2 mm thick insulation layer 32 which had 0.04 W/m·K heat conducting rate, except near both ends (of the sheet). And, a heater (18W) 33 was placed at the both ends of the graphite sheet 31, then the temperature was measured at the wrong side of the heater 33 (spot A), upper part of the heat insulation layer 32 (spot B), and at the other end of the graphite sheet (spots C,D); after the heater was turned on, the temperature was measured after 0.5 minutes, 2 minutes, 3 minutes, 4 minutes, 5 minutes, and 6 minutes. In Drawing 14, the distances a was 100mm, b was 30mm, c was 40mm, d was 150mm, e was 200mm, f & g were 40mm, and h was 120mm.

0041:

Also, as a comparison test with this invention, we prepared the same heat conducting material (Comparison Sample 1) in construction (with the Sample 1) except the insulation was not placed on both sides of the graphite sheet; (another) heat conducting material (Comparison sample 2), Al sheet (heat conducting rate=220W/m·K) was used instead of the graphite sheet, and the same kind of insulation layer was placed on both sides of the surface; in the heat conducting material (Comparison sample 3), A1 sheet only is used instead of the graphite sheet: and all samples were tested for temperature in the same way as the Actual Sample 1, after the heater was turned on at each spot (the same spots as the Actual Sample 1: A-D). The results are shown in Table 1. The temperature was measured in an airtight room (temperature 20°C, moisture 45%) to avoid the affect of air currents.

0042:

Table 1

1.Heat conducting material, 2. Measured spots, 3. Measured temperature, 4. (left to right) after 0.5 minutes, after 2 minutes, after 3 minutes, after 4 minutes, after 5 minutes, after 6 minutes, 5. Actual Sample 1, 6. Graphite + insulation layer, 7. Comparison Sample 1, 8. Graphite only, 9. Comparison Sample 2, 10. A1 sheet + insulation layer, 11. Comparison Sample 3, 12. A1 sheet only.

0043:

As it is clear from the Table 1, the temperature increase around the heat transfer route is not too large when the heat conducting material (the graphite sheet + the insulation layer) of the Actual Sample 1 is used, as is compared with the Comparison Sample 1(graphite sheet only) ; also it is obvious that the heat is transferred to the radiator parts (C, D spots) effectively (temperature increase is large). In addition to that, for the heat conducting material in the Actual Sample 1, when it is compared with the Comparison Sample 2 (A1 sheet + the insulation layer) using A1 sheet, the temperature at the radiator part (C, D) goes up quickly; this shows that the heat conducting in both directions is excellent.

0044:

Actual Sample 2, Comparison Sample 4-5

We constructed a heat conducting material and heat radiating construction as shown in the Drawings 15-17, using a graphite sheet with the same characteristic as in the Actual Sample 1. First, on the upper side of the graphite sheet 41, heater (10W) 42 was attached, and on the other sides, polyurethane foam insulation layer 43 in 1mm thickness was attached. Then under the graphite sheet 41, A1 sheet 44 was laminated. The insulation layer 43 is between the graphite sheet 41 and A1sheet 44. The temperature at the lower part (A spot) of the heater where it is placed at the wrong side of A1 sheet 44, and at the spot (B spot/A-B distance=55mm) 50mm away from heater 42, were measured: the measuring times were, when the heat 42 started (beginning value), and 1, 3, 5, 10, 15 minutes after the heater was turned on.

0045:

Also, as the comparison with this invention, we prepared; as shown in Drawing 18, a heater 42 was placed onto the A1 sheet 44, with 1.5W/m·K heat conduction rate and 1mm thick thermal sheet 45 between (Comparison 4); also as shown in the Drawing 19, one with everything the same as the Actual Sample 2 except it did not have any insulation (Comparison 5): the temperature was measured after the heater was turned on, in exactly the same way as in the Actual Sample 2 at each spot (same spots as in the Actual Sample 2: A-B spots). The temperature was measured in an airtight room (temperature 23.7°C) to avoid the affect of the air currents.

0046:

Table 2

1. Heat conducting material, 2. Measured spots, 3, Temperature after the measurement, 4. (from left to right) beginning value, 1, 3, 5, 10, 15 minutes later, 5. Actual Sample 2, 6. Graphite + insulation layer + A1 sheet, 7, Comparison 4, 8. Thermal sheet + A1 sheet, 9. Comparison sample 5, 10. Graphite + A1 sheet.

0047:

As it is clear from the Table 2, the temperature increase around the lower area of the heater (A) is not too large when the heat conducting material (the graphite sheet + the insulation layer + A1 sheet) of the Actual Sample 2 is used, when it is compared with the Comparison Sample 5: also the heat conducting rate to both directions on the surface is better than Comparison Sample 4. It means that the temperature at the B spot in the Actual Sample 2 is higher than in the case of Comparison Sample 4, because the temperature at that place is the one with heat dispersion effect of the graphite sheet with excellent heat conduction toward both direction of the surface.

Simple Explanation of the Drawings

0048:

Drawing 1: cross section of overall construction of the heat conducting material according to No.1 actual form of this invention.

Drawing 2: cross section of the heat conducting material in the Drawing 1 with partial change.

Drawing 3: cross section of the heat conducting material in the Drawing 1 with another form of change.

Drawing 4: a sample of a construction of the heat conducting material according to the actual form of No. 1 invention.

Drawing 5: another sample of a construction of the heat conducting material according to the actual form of No. 1 invention.

Drawing 6: one more different sample of a construction of the heat conducting material according to the actual form of No. 1 invention.
Drawing 7: a sample of a construction of the heat conducting material according to the actual form of No. 2 invention.
Drawing 8: the upper plane of the heat conducting material of the Drawing 7.
Drawing 9: the lower plane of the heat conducting material of the Drawing 7.
Drawing 10: cross section of the overall construction of the heat radiating system according to the No.1 actual form of this invention.
Drawing 11: cross section of a sample with a different shape of the heat radiating system in the Drawing 10.
Drawing 12: cross section of the overall construction of the heat radiating system according to the No.2 actual form of this invention.
Drawing 13: cross section of the heat conducting material and radiating construction according to the Actual Sample 1 of this invention.
Drawing 14: the upper plane of the heat conducting material and heat radiating construction of the Drawing 13.
Drawing 15: the upper plane of the heat conducting material and heat radiating construction according to the Actual Sample 2 of this invention.
Drawing 16: cross section of heat conducting material and the heat radiating system according to Drawing 15.
Drawing 17: lower plane of the heat conducting material and the heat radiating system according to Drawing 15.
Drawing 18: upper plane of the heat conducting material and the heat radiating system according to Comparison Sample 4.
Drawing 19: upper plane of the heat conducting material and the heat radiating system according to Comparison Sample 5.
0049:
1, 11:heat conducting material, 2, 12: heat conducting body, 3, 13: endothermic parts, 4: heat radiating part, 5: heat transfer route, 6, 14: insulation layer, 21: semi conductor element as heat generator, 22: heat radiating fin as a radiator.

Name of the file: Summary

Summary
Purpose: to increase heat conduction rate of the heating body to the radiating body, and at the same time decrease bad thermal affect to other parts of the heat conducting material made of graphite molding body.
How to solve the problem: the heat conducting material 1 has a graphite molding body (heat conducting body) 2 that has the heat transfer route 5, and this heat transfer route 5 conducts the heat from endothermic part 3 to the radiator 4. The heat transfer route 5 made of graphite

molding body is covered at least partially with the insulation layer 6, in order to control heat dispersion around it.
Selected drawing: Drawing 1.

Name of the file: Summary

Summary

Purpose: to offer graphite compound that can prevent fall of graphite powder from the end of the graphite sheet easily and surely.

How to solve the problem: graphite compound with following features: graphite sheet 11 which has high heat conducting characteristic on both sides, has 2 sheets 12, 12 made of either laminated metal or ceramics, and these 2 sheets 12, 12 are both extruded from the graphite sheet 11, and by pressing this extruded part 12a into one body, the exposed part of both ends of the graphite sheet 11 is closed.

Selected Drawing: Drawing 1.

RECEIPT

January 26, Heisei 16 (2004)
Head of the Patent Office

File number	100077849
Name	Saichi Suyama (Mr.)
Application date	January 26, Heisei 16 (2004)

I have received the following file:

Item Number	Name of the file	File Number	Received Number	Application Notice (disclosure)
1	Patent	DXX03-031	50400126725	Tokugan2004-17710

End